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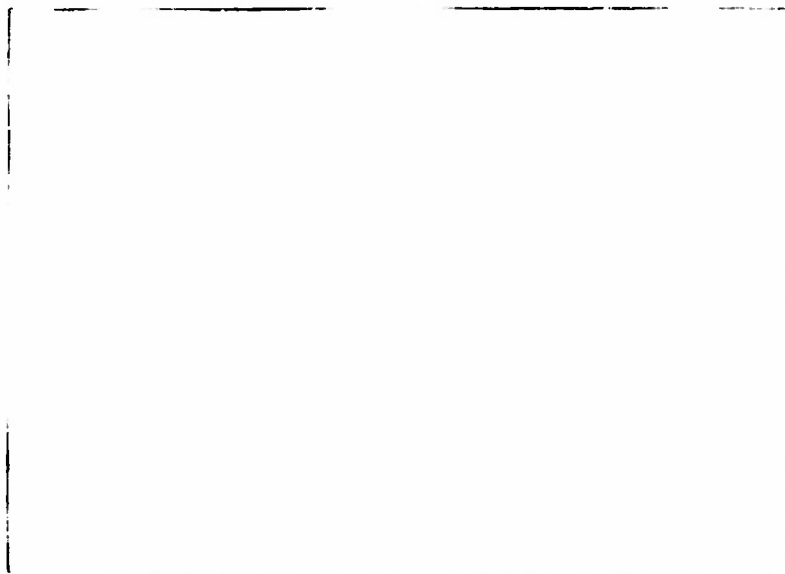
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# THE UNIVERSITY OF WISCONSIN

COLLEGE OF LETTERS AND SCIENCE



DEPARTMENT OF GEOLOGY  
DIVISION OF GEOPHYSICS

Madison, Wisconsin

UNIVERSITY OF WISCONSIN

Department of Geology

PROGRESS REPORT

Period

January 1, 1954 to September 30, 1954

Seismic Studies in the Southern Half of the  
Atlantic Coastal Plain  
(Not Classified)

The enclosed represents work done to date under  
contract N 7 onr-28512, between the Office of Naval  
Research, U.S. Navy, and the University of Wisconsin.

October 1954

To: Office Naval Research  
Geophysics Branch  
Washington, D. C.

From: George P. Woollard  
Department of Geology  
University of Wisconsin  
Madison, Wisconsin

Subject: Progress report on seismic studies in the southern half of the Atlantic Coastal Plain. Period, January 1, 1954 to September 30, 1954.

1. The following report covers work done during the summer field season of 1954 and experimental work conducted in the spring of 1954 under contract N7 ONR 28512 between the Office of Naval Research of the U.S. Navy and the University of Wisconsin.
2. Objective of Research Program: To establish a series of six seismic refraction depth profiles across the Atlantic Coastal Plain south of Cape Hatteras, N. C. in order to determine
  - (a) the depth of sediments overlying the pre-Cretaceous erosion (basement) surface
  - (b) the geologic structure within the sedimentary section
  - (c) the nature of the rocks comprising the basement surface
  - (d) the configuration of the basement rock surface.
3. Field Program: During the summer of 1952 seismic refraction measurements of the depth to the basement rock surface underlying the Coastal Plain were completed at 22 locations. During the summer of 1953 additional measurements were made at 35 locations. In 1954 land observations were limited to one set of refraction measurements and three sets of reflection measurements. In addition 10 sets of off-shore refraction measurements were made. As a preliminary to the marine work two sets of test refraction measurements were made in Lake Michigan off Milwaukee and considerable experimental work carried out in Lake Mendota at Madison, Wisconsin.

All of the refraction measurements were carried out using the reverse shooting technique in order to determine true velocity values for the seismic discontinuities mapped and to determine the true slope of each interface in the azimuth of the measurement.

To supplement the above depth measurements, and to serve as a guide for identifying the basement lithologic units indicated by the variations in the observed velocity values, velocity measurements were conducted over exposed basement rocks in the Piedmont region at 50 localities. These measurements not only indicated the variations to be expected in basement velocity values but the degree of continuity of lithologic units to be expected within the basement complex.

Figure 1 shows the location of all measurements made to date under the program. It will be noted that the depth measurements are not complete in Georgia and the coastal region of South Carolina. As discussed in the progress report for the period June 1, 1953 - December 31, 1953 it was not found to be practical to continue the seismic refraction measurements southward near the coast from Myrtle Beach, S.C. because of

- (a) the difficulty of laying out long seismic lines in the swamp areas
- (b) poor radio communication over the distances involved in the heavy forests of the region
- (c) public disfavor occasioned by the large charge of explosives required.

In Georgia work was handicapped by these same factors near the coast and also two additional items --

- (a) unfavorable geologic conditions for refraction measurements over much of the area occasioned by the introduction of limestone in the geologic sedimentary section.
- (b) the shortage of time for field work that resulted from having to build equipment for marine work in order to extend the profiles beyond the coast so that extrapolations of structure within the coastal area could be made.

The 1954 marine field program was only possible through the courtesy of the U. S. Coast Guard, who cooperated on the off-shore measurements by making the cutters AURORA and TRAVIS available for the seismic studies, and the courtesy of the Humble Oil and Refining Co., who made available certain special equipment that was needed for the measurements.

Although the help of the Humble Oil Co. was the principal factor in permitting this work in that they made available four gymbal mounted geophones, two hydrophones, and several thousand feet of 12 conductor cable, all of the equipment, other than the cable, had to be taken apart and completely rebuilt, cable take-outs made, and the whole integrated with the amplifiers and recording equipment already on hand. As the Coast Guard had only agreed to the use of the AURORA for the measurements on an availability basis for a two-weeks period, it was essential that all equipment be in operating shape and tested before leaving Madison. As a result the field measurements did not start until nearly the middle of August.

Of the ten marine refraction seismic stations established, eight were made using only the AURORA and a motor launch. On the last two stations established under bad sea conditions during the period between hurricanes Carol and Edna with a spread of 24 miles, the cutter TRAVIS was temporarily assigned to act as a shooting vessel.

4. Observational Procedure Used: The general procedure followed in making the measurements was to stream 4 gymbal mounted geophones along the bottom located at 400 foot intervals on the cable astern of the AURORA which then anchored. The shooting boat would then make an approach firing TNT charges electrically at a depth of about 7 feet on a radio arranged schedule and pass the AURORA. Charges were then

fired in the opposite direction to such a distance as to give adequate data for determining the depth to basement. In this way velocity data were secured in two directions along a given heading. On the last pair of stations off Charleston, shooting was carried out to a distance of 24 miles as a full reverse profile. At all other stations the shooting distances varied from one to five miles beyond a central point. The location of these measurements in respect to other off-shore seismic measurements is shown in Figure 2.

Distances were determined by radar, and each geophone arrival was recorded separately at three different gain settings differing by a factor of 10. Water wave arrivals if the explosion were also recorded with a hydrophone.

Table I gives the principal facts for each off-shore station established. The total time spent at sea was 29 days. The actual number of days on which it was possible to work was 13.

TABLE I

| Sta | Lat.    | Long.   | Depth  | Shot spread from Ship*    | Number Charges | Size Charges |
|-----|---------|---------|--------|---------------------------|----------------|--------------|
| 1   | 33°27'N | 77°28'W | 14 fms | 4250 yds NE-2430 yds SW   | 36             | .5 - 55 lbs  |
| 2   | 33°54'N | 77°32'W | 11 fms | 4550 yds NR-5000 yds SW   | 31             | 0.5 - 55     |
| 3   | 33°45'N | 77°32'W | 11 fms | 4400 yds NE-3700 yds SW   | 45             | 0.5 - 75     |
| 4   | 33°35'N | 77°45'W | 17 fms | 2900 yds NE-2320 yds SW   | 20             | 0.5 - 35     |
| 5   | 33°17'N | 77°52'W | 16 fms | 3840 yds NE-2900 yds SW   | 25             | 0.5 - 100    |
| 6   | 33°29'N | 78°06'W | 12 fms | 2880 yds NE-2610 yds SW   | 22             | 0.5 - 50     |
| 7   | 33°16'N | 78°22'W | 12 fms | 3000 yds NE-3440 yds SW   | 24             | 0.5 - 50     |
| 8   | 32°58'N | 79°00'W | 12 fms | 6000 yds NE-8000 yds SW   | 59             | 0.5 - 100    |
| 9   | 32°45'N | 78°15'W | 12 fms | 14000 yds SE              | 8              | 0.5 - 224    |
| 10  | 32°06'W | 79°31'W | 21 fms | 9000 yds SE-41,000 yds NW | 31             | 0.5 - 224    |

\*All distances are RADAR ranges. Check distances based on the travel time of sound in sea water for temperature conditions indicated by a bathy-thermograph were also obtained.

Stations 9 and 10 were established immediately after the passage of hurricane Carol and as hurricane Edna was approaching operations were secured on Sept. 8, 1954.

4. Results: Whereas on land it was found that in the North Carolina-South Carolina region two and occasionally three seismic layers existed above the basement surface characterized by velocities of 2600-4000 ft/sec., 5700-6800 ft/sec and 7000-8000 ft/sec, at sea only two seismic layers are indicated above the basement in the records worked up to date.

The upper one has a velocity of 5050-5200 ft/sec and the lower one 6000-6600 ft/sec. These results apply to stations in the Cape Fear region where the basement rocks rise about 2000 feet above the general level of the basement in the geologic structure known as the Cape Fear Arch. The strike of this structure is approximately perpendicular to the coast line and it appears to carry from the land area well out to sea.

In the Georgia land work carried out on the completion of the marine work, an attempt was made to establish an empirical correlation for refraction measurement at one deep well to basement near Pearson. It was found that a sharp break in velocity from 6600 ft/sec to slightly over 10,000 ft/sec is present at 250 feet and no further change in velocity is indicated until the basement is reached (over 4000 feet). The first indication of basement rocks was not obtained until the spread between shot and receivers was over 5 miles. This indicates a velocity reversal which rules out refraction studies. Also, at such distances the size of explosive charge required is too large for the cultural development of the country. As a result, it was decided to switch to reflection methods.

As the season at this time had advanced until past the opening of the University for the Fall term, the reflection measurements were more of a trial nature and confined to a single area near Tifton, Ga.

Acknowledgments: The assistance of the U.S. Coast Guard and especially Lt. Cmdr. J. W. Coste, Commanding Officer of the cutter AURORA and his officers and crew are especially remembered. Likewise, the help of the Humble Oil and Refining Co. in making available seismic equipment for the marine work is gratefully acknowledged, as is the Woods Hole Oceanographic Institution for the loan of a bathythermograph. In carrying out the work in Georgia the help of Capt. Garland Peyton in arranging for work through the County Commissioners of the counties involved is also acknowledged. Finally, the assistance of the various ONR officers who arranged for the use of a Navy 2-ton truck and securing explosives as well as making arrangements with the U.S. Coast Guard can not be overemphasized.



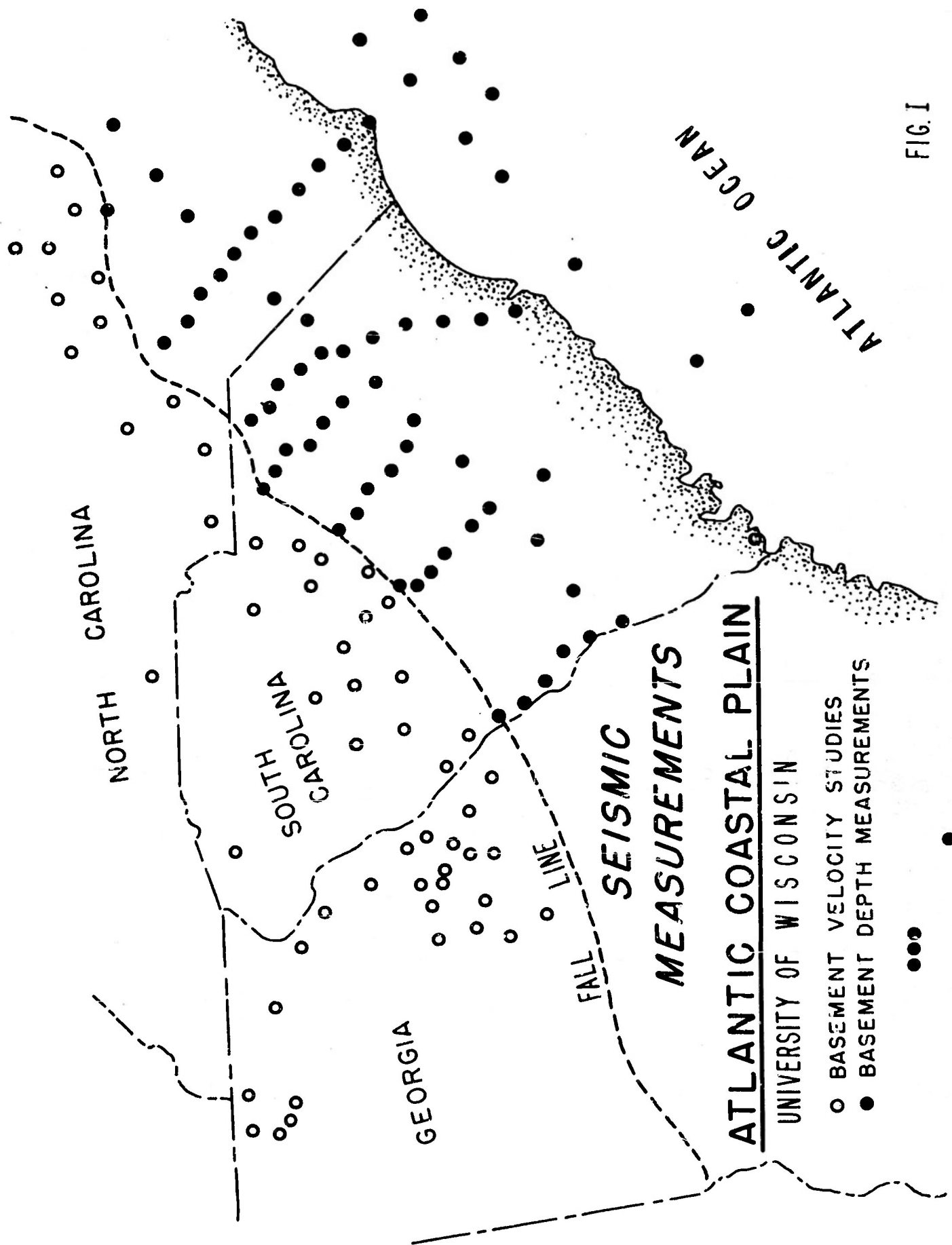


FIG. I

# SEISMIC MEASUREMENTS

## ATLANTIC SHELF

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- OTHER

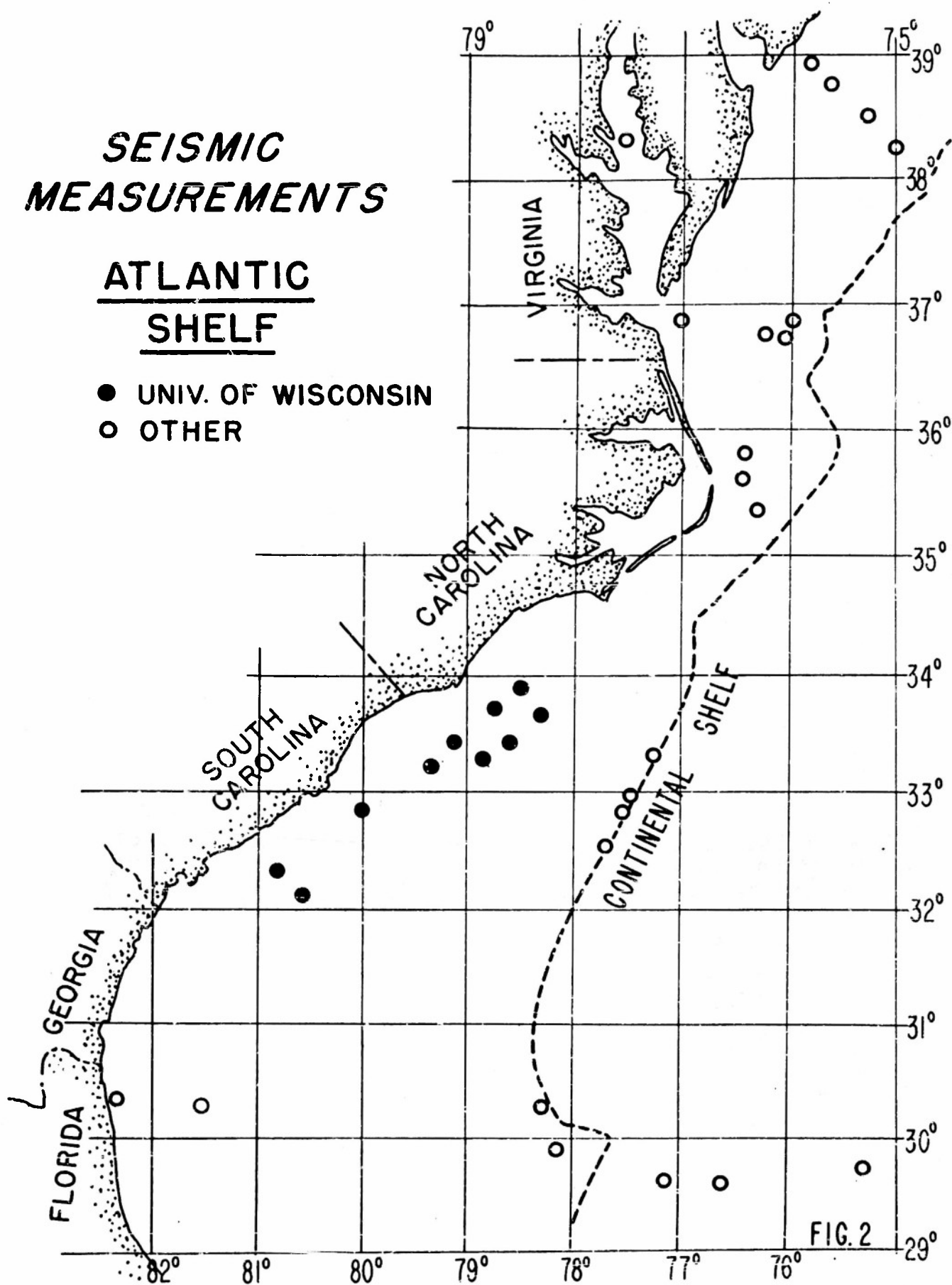


FIG. 2

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